NORTHERN ONTARIO WATER RESOURCES STUDIES

Geological Survey

1967

by

C. G. Hamilton

ONTARIO WATER RESOURCES COMMISSION

Division of Water Resources

Toronto Ontario

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GEOLOGY

Introduction

The area covered includes parts of the Severn, Winisk, Attawapiskat and Albany river basins in northern Ontario, (Fig. 1). These rivers drain into Hudson Bay and James Bay. In the southern or upper part of the area drained by these rivers the record left by successive Pleistocene glaciers is clearly imprinted on the landscape. In the lower reaches, the land is flat, swampy, and otherwise featureless except for a few lakes and river gorges which are deeply incised in the thick cover of glacio-marine sediments and sedimentary rocks which overlie the Precambrian basement rocks. This flat area comprises the Hudson Bay lowland. The Hudson Bay lowland and a large part of the area adjacent to the lowland which is underlain by Precambrian rocks, are covered by extensive swamps, string bogs and varying thicknesses of peat and muskeg.

The geology was examined and reported upon by C. G. Hamilton and N. Dorff. Minor changes to the manuscript were made by other staff of the Division of Water Resources after Mr. Hamilton left the employ of the Division.

Severn River Basin

The Severn River basin (Fig. 2) can be subdivided into

five physiographic subdivisions based upon the nature of the overburden, the relief, the amount of rock exposure, and, to a lesser degree, the drainage pattern. These subdivisions are:

(1) a rocky belt

(2) the Hudson Bay lowland

(3) major moraines

(4) a clay belt

(5) a sandy till belt

Other discontinuous features include silt deposits and eskers.

Rocky Belt

In the upper part of the Severn River basin, there is an area extending eastward from the Manitoba-Ontario border to a line extending approximately from McDowell Lake in the south through the eastern end of Sandy Lake thence northwesterly to Opasquia Lake which is relatively rugged with extensive bedrock exposure. The bedrock is predominantly massive leucocratic, pink granitic, granodioritic and monzonitic rocks, foliated granitic to monzonitic rocks, and meta-sedimentary and meta-volcanic rocks of Precambrian age. These rocks have been deformed and dislocated in many places so that there are numerous faults and prominent lineaments which determine the courses of some of the streams and the alignments of lakes.

This rocky belt was overlain by Lake Agassiz which

left extensive deposits of silt and varved clay in the area. Most of these surficial deposits have been removed by subsequent erosion and at present only the depressions which are still covered with varved clay and silty clay indicate the nature of the earlier surficial cover.

North, south and east of North Caribou Lake is an eastern extension of the rocky belt. This eastern part is discontinuous across the Severn River basin.

Hudson Bay Lowland

Almost one-third of the Severn River basin is a relatively flat almost featureless plain underlain by Silurian and Ordovician limestone and dolomite upon which thick deposits of glacial till, lacusttine silts and clays, and unconsolidated marine sediments lie. Overlying the marine sediments are thick deposits of peat and muskeg. As a result of the low gradient and the extensive deposits of peat and muskeg, a very large portion of the area is occupied by swamps and string bogs. This part of the river basin is adjacent to Hudson Bay.

From the work done in the Hudson Bay lowland, the writer has not been able to establish the Pleistocene stratigraphy. The only sections examined are along the Severn River north of the confluence with the Sachigo River, and the Winisk River, approximately six miles upstream from Hudson Bay.

The uppermost layer of overburden in the Hudson Bay lowland adjacent to the Severn River is a deposit of peat which is from two to fourteen feet thick and is underlain by an upper till-like deposit. This upper deposit is largely silt or exceedingly fine sand but contains numerous small well-rounded pebbles up to two inches in diameter. Pebbles two inches in diameter are rare, but one-half inch ones are common.

Thirty miles below the confluence of the Fawn and Severn rivers, the upper silty deposit is underlain by an eight-inch layer of exceedingly well-sorted, fine-grained sand along which ground water discharges. Below this fine sand, a semi-consolidated silty till similar to the upper deposit, but locally more clayey, is exposed for a vertical height in excess of forty feet above the water level of the river. At the extreme top of the exposed section which is over eighty-feet high, ten to twelve feet of sandy to gravelly material is present. Well-rounded boulders up to twelve inches in diameter are numerous. This deposit is adjacent to the river and is only of local extent, and it is not certain whether or not it is of marine, glacial or purely fluviatile origin. The latter is suspected. An upper silty till has been traced as far southwest as the Sachigo River. In places, a thickness in excess of ninety feet of upper till is exposed. Along the Fawn River McDonald (1967), reports two tills at the top

of the Pleistocene section.

The topography of the Hudson Bay lowland is one of an exceedingly flat plain with deep gorges cut into it by the Severn River and several of its tributaries. Away from the stream the only prominent features besides swamps and string bogs are raised beaches. These raised beaches are mostly arcuate in pattern and form low welt-like ridges of medium-grained well-sorted sands. In places the surface of the ridges do not rise above the plain as a whole, because the deeper muskeg and peat cover on either side of the ridges tend to even out the topography. The ridges are densely forested as a rule, and even where there is not dense forest, the vegetal cover is in striking contrast to that of the surrounding terrain. They often appear as a linear or arcuate forest of tall trees in an otherwise swampy terrain covered by bracken and moss.

The sorting coefficient for sands from a typical raised beach near the confluence of the Sachigo and the Severn rivers is 2.3 and the median diameter 0.38 mm.

Major Moraines

A prominent ridge system trends northerly from the eastern end of Sandy Lake past the western end of Sachigo and Little Sachigo Lakes, and then trends out of the Severn River basin into Manitoba. This ridge system has a local relief in excess of

three hundred feet. Its origin is due to two ice sheets, one of which originated in the northeast and moved in a southwesterly direction, while the other originated further west and moved S25°E (Satterly 1937). The ridge is therefore an interlobate moraine, probably due to two lobes of the Labradorean glacier.

The material which comprises the crest and steeper slopes of the ridge is a sandy till. The till contains exceedingly small quantities of material finer than medium-grained sand; and boulders up to eight feet in diameter are common. Prominent wave platforms and lake terraces are present on the slopes of the moraine. On some of these platforms, the finer material has been winnowed away by wave action and carried out into the deeper parts of the proglacial lakes which were present on either side of the ridge. The material left on the platform is therefore partly sorted and is predominantly coarse sand and gravel with numerous large boulders left in situ by the ice. The concentration of these large boulders on the platforms is one of the most striking features of the terrain.

On the lower slopes of the ridge, medium-grained and fine-grained sand are present. Away from the ridge, this sand becomes progressively finer and better-sorted until an area of silt which grades into clay is reached.

North of the east end of Sandy Lake, the Sachigo interlobate moraine is intersected by an end or recessional moraine which trends generally southeast and crosses the Severn River basin. In the vicinity of McDowell Lake, (Fig. 2), the moraine trends easterly to southeast of Windigo Lake where it joins the Agutua moraine (Prest 1963), which trends southeasterly into the Winisk River basin. Only on the north shore of Sandy Lake, has the writer examined the material composing this end or recessional moraine. At this location, the moraine is composed of predominantly poorly sorted or unsorted coarse to fine-grained medium brown sand with numerous boulders of "greenstone." The moraine rests upon melanocratic, meta-volcanic rocks (greenstones), which outcrop along the northeastern shore of Sandy Lake. In several places, the moraine is modified by waters from glacial lakes, and numerous ancient lake terraces and esker-like features are preserved on it. In addition, there are some eskers which cut across the Agutua moraine.

North of Sandy Lake and Opasquia Lake, there is a ridge which trends easterly and forms part of the divide between the Severn and the Gods rivers. This ridge is part of an end or recessional moraine. The composition of the moraine has not been observed in the field but from air photographs, the writer concludes that the southern part of the moraine is probably clayey or silty

with sandy till only locally present; whereas the northern part has more sandy till. Prominent lake terraces and beach ridges are present in the northeastern part of the moraine.

Clay Belt

Extending across the central part of the upper Severn River basin is an area of predominantly lacustrine clays, silty clays and clayey silts. The area also extends from northwest of Sandy Lake northwestwards to the western limit of the basin. The sediments are partly uniform clays, but much of the deposits exhibits prominent varved structures at places such as Makoop Lake, Sachigo Lake and Muskrat Dam Lake. At Sachigo Lake the varved clay is exposed in sections up to 25 feet thick on the northwestern part of the lake. Active slumping of the clay where it is undercut by wave action is in progress. The waves winnow the clay which becomes dissipated in the water of the lake and this accounts for the pale brown colour of the lake water. A similar situation is present at Sandy Lake and Whiteloon Lake, where the lake waters are an even more vivid brown than at Sachigo Lake.

Wherever the base of the clay is exposed, it has been observed to rest upon leucocratic granitic gneisses or mesocratic meta-volcanic rocks. At Sachigo Lake, clay rests upon conglomerate in at least one of the islands in the lake.

The area covered by clay and clayey silt tends to be

swampy and relatively flat, though numerous small low knolls rise above the general relief. The areas adjacent to depressions occupied by rivers and lakes, especially the varved clay, are better drained and the vegetal cover is taller and more luxuriant. Tall spruce and poplar and birch thrive. Jack-pine in the clay belt is restricted to rocky knolls and ledges and eskers.

On the north shore of Sandy and Sachigo Lakes, the varved clay near the surface is folded and contorted probably due to slumping, the action of the roots or to later ice overriding. Several prominent eskers are present in the clay belt as well as some less prominent eskers or moraines partly modified by the action of running water. Several small areas of sandy till are present in this belt.

Sandy Till Belt

Most of the central part of the Severn River basin is covered by ground moraine composed predominantly of sandy till. The till plain is relatively flat or gently sloping to the northeast. Although the superficial cover is largely sandy till, there are scattered zones of clayey till, clay, sand and silt included in this area. The blanket of sandy till extends north and northeast of the Precambrian-Paleozoic boundary and much of the area designated as Hudson Bay lowland is covered by sandy till.

East of Severn Lake and northeast of Big Trout Lake,

the sandy till is extensively and deeply fluted by glacial action. The fluted ridges and depressions extend great control over the direction of stream courses and the shapes of the lakes in the area.

The median grain size of the sandy till is extremely variable from place to place. In some areas, boulders in excess of six inches in diameter are common. The silt and clay-sized fraction of the till is small or absent in most samples. In all localities, the till is covered with peat and/or muskeg of from one-half to ten feet in thickness. The peat and/or muskeg tend to form a good insulating layer for the till, so that the soil moisture in the upper part of the till and the lower part of the peat or muskeg is permanently frozen. In most places south and west of Big Trout Lake, the frozen zone was found to be one and one-half to two feet below the surface in late August. On top of the more prominent ridges, the peat/muskeg layers tend to be thinner, the soil is better drained and, in addition to the spruce and birch which are the predominant vegetal type in the area of sandy till, jack-pine may be present.

Only in a few places was the bedrock underlying the sandy till zone observed. West of Big Trout Lake, it is predominantly feldspar-biotite gneiss with minor amphibolite and greater amounts of volcanic rocks, including basalt, andesite and dacite. Throughout most of the remainder of the area, the bedrock appears to be quartz-

feldspar-biotite gneiss; although few outcrops have been seen along many of the lakes, large ice-rafted boulders composed of quartz-feldspar-biotite gneiss are numerous.

Eskers

Glacio-fluvial deposits are prominent in the central part of the Severn River basin. They form long, narrow, sinuous ridges called eskers, the great majority of which trend south-westerly and thus parallel the dominant direction of streams, the long axes of most of the lakes, the glacial straie as well as the axis of the Severn River basin. Glacio-fluvial deposits also form small kame moraines.

Most of the eskers examined are composed of unsorted sediments with well rounded boulders of varying sizes. Some are gravelly, others are sandy. Few have a dendritic pattern, but most are discontinuous and only a few miles in extent. In the clay belt some of the eskers appear to be emplaced on top of the varved clay, but some are covered with a thin deposit of clay and thus are older than the proglacial lake which later covered parts of the central Severn River basin.

The eskers represent well-drained, sandy or gravelly soil, and frequently have several kettles in them. Several of them are stratified. Jack-pine, Poplar, birch and large spruce are the dominant trees. Because of the well-drained soil, the trees tend to be larger than those off the eskers, although in the same vicinity.

Winisk River Basin

The mapping of the Winisk River basin has been done mostly with the aid of air photographs as the writer was unable to carry out extensive traverses within the area. The only sites examined on the ground were near the outlet of the Winisk River, one location along the Morris River in the southwest, and the southeastern corner of the basin between Mameigweis and Winisk Lakes, (Fig. 3).

The Winisk River basin can be subdivided into six major physiographic subdivisions:

(1) the floor of the Tyrell sea

(2) a central till plain

(3) a clay belt

(4) a rocky belt

(5) the Agutua moraine

(6) a southwestern till plain

Floor of the Tyrell Sea

Whereas the name Hudson Bay lowland is usually restricted to that area adjacent to Hudson Bay and James Bay and that is underlain by Paleozoic sedimentary rocks, there is an area of lowlands immediately south of the Precambrian-Paleozoic boundary which is similar in relief and vegetation to the lowland.

This area, like most of the Hudson Bay lowland, was covered during part of the Pleistocene by an extensive sea, the Tyrell Sea. This sea was the last marine transgression upon the area. On the accompanying map of the Winisk River basin (Fig. 3), the extent of the Tyrell Sea is indicated by symbols 2 and 8 of the legend.

Within the Winisk basin, the part of the floor of the Tyrell Sea occupied by the Hudson Bay lowland, as far as could be determined, contains sediments similar to those found in the Hudson Bay lowland in the Severn River basin. Some of it, however, is covered by a marine plastic clay.

South of the Hudson Bay lowland, the old sea floor is covered by a thin veneer of well-sorted silt or very fine sand. Where examined in the vicinity of Prime and Winisk Lakes, the silt and sand layer was frozen and overlain by one or two feet of peat. Below the silt is sandy to clayey till. West of the Tabasokia Channel (Fig. 3), raised beaches are prominent.

No bedrock has been observed along the southern limit of the sea floor but at the Precambrian-Paleozoic contact, quartz-diorite, granodioritic, schlieren or biotite-quartz-feldspar gneisses are in contact with Ordovician limestones or sandstones.

Central Till Plain

The central till plain (symbols 5 and 7 on the map) extends from the southeastern extremity of the Winisk River basin,

east of Mameigweis Lake to west of the Ashweig River and north of Long Dog Lake. The area is covered by ground moraine which is well-fluted. The fluted ground moraine controls the drainage pattern and the shape of the lakes in the area. The entire area is carved into low ridges and furrows which trend southwesterly. The ridges form low divides between the streams, which together with the lakes, occupy the furrows. In the southeastern extremity of the basin, the ground moraine is predominantly sandy till with patches of clayey till. Both the tills are exceedingly heterogeneous with a variety of well-rounded boulders, cobbles, gravels and sand-silt-and clay-size particles.

The plain is covered by peat and muskeg from one-half to several feet in thickness. In the swampy areas, tamarack and small spruce are present. In the less swampy and more well-drained sandy areas, larger spruce, birch, balsam and minor poplar are the predominant trees.

Bedrock exposure is relatively inextensive in the till plain but along the shores of lakes, huge boulders of feldspar-quartz-biotite gneiss are present. Along the Ashweig River near Long Dog Lake, Silburn et al, 1966, report pink granitized hornblende-biotite gneiss in outcrop.

Clay Belt

The central till plain is bounded to the south by a

belt of clay with a thick cover of muskeg. This belt of clay transects the Winisk River basin and trends southeast. It is relatively narrow and probably does not exceed fifteen miles in width except in the eastern part in the vicinity of Pinemuta Lake. The exact nature of the clay in this belt has not been determined.

Rocky Belt

There is an area north and south of Opapimiskan Lake where outcrop predominates. This area is an extension of the eastern rocky belt of the Severn River basin and is similar to it in all respects.

Agutua Moraine

The Agutua moraine transects the Winisk River basin in the southwest, trending east-southeasterly as it does so.

Southwestern Till Plain

South and southwest of the Agutua moraine is an area of sandy till, sand and undifferentiated ground moraine. In the vicinity of Horseshoe and Stirland Lakes (Fig. 3), the ground moraine is suspected to be sandy from air photographic interpretation, but it has not been positively identified. Near Kinlock Lake, a poorly sorted, medium to coarse-grained sand which comprises outwash overlies coarse-grained porphyritic granite; however, most of the southwestern extremity of the Winisk River basin is covered by a ground moraine which appears to be predominantly sandy till.

Eskers and Minor Moraines

Across the southwestern till plain are several long eskers, one of which completely traverses the river basin. The eskers have an easterly trend. Other eskers south of Pinemuta and Mameigweis Lakes also trend easterly or east-northeasterly. The great majority of the eskers in the clay belt and the central till plain have a northeasterly trend and thus parallel those of the Severn River basin.

Small end, or recessional moraines trend southeasterly from Opapimiskam Lake and also in the central part of the basin near the northern limit of the clay belt.

Drainage Control

Both the Severn and Winisk river basins have long axes trending northeast. Most of the tributary streams flow northeasterly and this is also the dominant direction of orientation of the long axes of the lakes. The furrows and ridges due to glacial fluting trend southwest as do glacial striae.

The direction of much of the drainage can therefore be attributed to glaciation since the latest glaciers to move over the area, moved southwesterly. This is attested by both eskers, glacial striae and the southeastern trend of the end moraines.

Attawapiskat River Basin

The work done in the Attawapiskat River basin was restricted to the stream gauging sites on the Dobie River and

Lysander Creek, and the observation well site at the Otoskwin River near Badesdawa Lake (See Fig. 1 for locations). For a more complete report on the Attawapiskat River basin, the reader is referred to "Report on Hydrological Investigation of the Attawapiskat River, Ontario Water Resources Commission," Gibb et al, 1967.

In the vicinity of the stream gauging site on the Dobie River, the country rock which a porphyrytic, medium or coarse-grained, biotite granite is overlain by a thin veneer of poorly sorted brown sand or sandy till. In some areas, extensive deposits of peat are present and these exceed ten feet in depth in places. Where peat is present, there is a frozen zone between one and two feet below the surface.

The Otoskwin River near Badesdawa Lake breaches the Agutua moraine and extensive fluviatile sorting of the moraine has resulted. In addition, outwash from the moraine has been sorted by lake waters so that on the northeastern and southwestern side of the moraine, the sandy till of the moraine is flanked by silt which on the outer margin of the silt, grades into clay.

Prominent levees of silt have been constructed by the Otoskwin River, or its antecedent stream, alongside the river below Badesdawa Lake. The accumulation of silt here is over ninety feet thick in the vicinity of the observation well and rests upon hornblende-biotite-quartz gneiss.

The upper reaches of Lysander Creek drain the sandy

till zone of the Agutua moraine and silt-sand ridges associated with the moraine; whereas the lower reaches pass through a silty zone flanking the outwash.

The area along the periphery of Missisa Lake was mapped during the early summer. Thick deposits of peat surround the lake in all places. Much of it is in excess of twelve feet thick and is usually frozen at one to two feet below the surface. In these areas, tall spruce is the dominant vegetation as compared with the bracken and scrub spruce in the areas of more homogeneous clay. In places along the lake shore, the clay is thixotropic.

Albany River Basin

Work in the Albany River basin was restricted to the area adjacent to the stream gauging sites at Mammamattawa, the Flint and Kenogami Rivers (See Fig. 1).

The gauging site and the proposed well site at Mammamattawa River are near the assumed contact of the upper Silurian limestones and dolomite with the arenaceous and cherty limestones of the Lower Devonian Stooping River Formation.

The overburden is of undetermined thickness but exceeds fifty feet. Near the surface, medium-grained, fine and very fine sand and silt form a graded, bedded succession. The silt is intermixed with clay in some places. The graded bedding, distinct layering and the fair to well-sorted nature of the sediments indicate

deposition in the Tyrell Sea.

At the Kenogami and the Flint Rivers (See Fig. 1), the overburden is similar to that at Mammamattawa River. A graded, bedded succession ranging from clayey silt to fine sand, forms a cover 0- to 6-feet thick over the bedrock which is quartz diorite at the Flint, but granitic cataclasite at the Kenogami River. The banks of the Kenogami River near the Canadian National Railway tracks expose over six feet of clayey silt overlying approximately twenty feet of sandy silt. The underlying rocks are sheared and the great thickness of overburden is probably due to a buried valley in the sheared rocks.

CONCLUSION

The Severn and Winisk Riverbasins both lie in Precambrian rocks in their upper reaches, and in Paleozoic rocks in their lower reaches. The Tyrell Sea was not restricted to the area covered by Paleozoic rocks, but also covered parts of the area underlain by Precambrian bedrock.

A belt of clay deposited by proglacial lakes transects the Severn and Winisk River basins. Northeast of the clay belt, ground moraine and sandy till are the predominant surficial deposits. Southwest of the clay belt are extensive deposits of end, or recessional moraines and large areas of bedrock exposure.

Many streams in the Severn and Winisk River basins owe their direction of flow to glacial control. Most streams, lakes, eskers and glacial striae in these basins trend northeast-southwest and this is the direction of a major ice advance and retreat in the area.

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FIG. 1.

ONTARIO WATER RESOURCES COMMISSION
DIVISION OF WATER RESOURCES

WATER RESOURCES SURVEY

NORTHERN ONTARIO

MAP 2006-1

HUDSON BAY DRAINAGE BASINS

PRELIMINARY MAP

1 Inch to 50 Miles

~~Scale 1:1,267,200 or 1 Inch to 20 Miles~~

1967 STREAM GAUGING SITES

WELLSITE

Mamamattawa

Flint

Kenogami

HUDSON BAY

JAMES BAY

LAKE SUPERIOR

NELSON

MANITOBA

ONTARIO

KENORA

RAINY RIVER

WINISK

ATTAWAPISKAT

EKWAN

KAPISKAU

ALBANY

THUNDER BAY

MOOSE

HARRICANAW

SUDBURY

TIMISKAMING

CHAPLEAU

Longlac

Geraldton

Nipigon

North Channel

LEGEND

- 9 ALLUVIAL DEPOSITS
- 8 MARINE SEDIMENTS (undifferentiated)
- 7 GROUND MORAINE (— —)
- 6 ESKER - ESKER - MORAINE COMPLEX
- 5 SANDY TILL, SAND
- 4 CLAY, CLAYEY - SILT, SILTY - CLAY
- 3 RECESSIONAL MORAINE, END MORAINE
- 2 HUDSON BAY LOWLANDS (undifferentiated marine, fluviatile, glacial deposits)
- 1 AREAS OF EXTENSIVE BEDROCK EXPOSURE

- DRUMLINS
- DIVIDE, COASTLINE
- APPROXIMATE CONTACT BETWEEN SURFICIAL DEPOSITS
- FAULT, LINEAMENT
- GLACIAL STRIAE
- PRECAMBRIAN - PALEOZOIC BOUNDARY
- RAISED BEACHES

FIG. 3.

PLEISTOCENE GEOLOGY
WINISK RIVER BASIN
ONTARIO

5 0 5 10 15
SCALE IN MILES

MARCH 1968

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HUDSON BAY

EKWAN RIVER BASIN

SEVERN RIVER BASIN

ATTAWAPISKAT RIVER BASIN

ALBANY RIVER BASIN

PALEOZOIC

PRECAMBRIAN

WINISK RIVER

KINGFISHER LAKE

WUNNUMIN LAKE

OPUTIMMIN LAKE

HORSESHOE LAKE

KNUCKLE LAKE

MOOSE LAKE

CONSTANCE LAKE

MANEIGWES LAKE

ONTAKE LAKE

RECESSIONAL MORAINE

55°00'N

54°00'N

53°00'N

52°00'N

92°00'W

88°00'W